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NOTES ON GEOGRAPHIC DISTRIBUTION

Digenean parasites of the Neotropic Cormorant, *Phalacrocorax brasilianus* (Gmelin, 1789) (Aves: Phalacrocoracidae) from Argentina: Distribution extension and new host records

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ABSTRACT: Thirteen specimens of *Phalacrocorax brasilianus* (Gmelin, 1789) from three areas of the Chaqueña Subregion of Argentina were examined for digeneans. Ten species were found: four diplostomids (*Austrodiplostomum mordax*, *A. ostrowskiae*, *Tylodelphys adulta* and *Hysteromorpha triloba*), three echinostomatids (*Drepanocephalus spathans*, *Paryphostomum segregatum*, and P. *parvicephalum*), one strigeid (*Strigea falconis brasiliana*), one psilostomid (*Ribeiroia ondatrae*) and one prosthogonimid (*Prosthogonimus ovatus*). *Tylodelphys adulta* and *S. f. brasiliana* are reported for the first time as parasites of *P. brasilianus* and new geographical records are presented.

Phalacrocorax brasilianus (Gmelin, 1789), commonly known as the Neotropic Cormorant or Biguá, is a phalacrocoracid bird distributed from the south of the USA to Cape Horn, Patagonia (Orta 1992). The species is widespread in Argentina and occupies a spectrum of wetlands in fresh, brackish and salt waters. They are opportunistic and generalist ichthyophagous feeders, foraging predominantly on fish and less intensively on crustaceans and mollusks, that usually exhibit a strong site fidelity (Casaux *et al.* 2009).

In Argentina, the digenean fauna of *P. brasilianus*, was studied during several opportunities, and at present 11 digenean species belonging to 10 genera and four families have been reported: *Austrodiplostomum mordax* Szidat and Nani, 1951, *Dolichorchis bonariensis* Ostrowski de Núñez, 1970, *Hysteromorpha triloba* (Rudolphi, 1819), *Neodiplostomum travassosi* Dubois, 1937, *Posthodiplostomum obesum* Lutz, 1928 (Diplostomidae); *Drepanocephalus spathans* Dietz, 1909, *Ignavia olivacei* Ostrowski de Núñez, 1967, *Paryphostomum fragosum* (Dietz, 1909) (considered as *species inquirenda* by Kostadinova *et al.* 2002), *Paryphostomum segregatum* Dietz, 1909, (Echinostomatidae); *Odhneria odhneri* Travassos, 1921 (Microphallidae), and *Ribeiroia ondatrae* (Price, 1931) (Psilostomidae) (Lunaschi *et al.* 2007).

Thirteen specimens of *P. brasilianus* were captured by shotgun between 1999 and 2004 in three areas from the Chaqueña Subregion of Argentina, defined according to Morrone (2001). Eleven birds were collected in Lacombe Lagoon (35°49' S, 57°49' W), Lezama, Buenos Aires Province (La Pampa biogeographic province), one in La Marcela farm (26°17' S, 59°06' W), Pirané, Formosa Province, and one in Clorinda (25°17' S, 57°43' W), Pilcomayo, Formosa Province (Chaco biogeographic province). The host birds were captured with authorization of Ministerio de Asuntos Agrarios of Buenos Aires Province and Ministerio de la Producción y Ambiente of Formosa Province. The birds were dissected in the field; the viscera were preserved in 10% formalin and transported to the laboratory for examination. The viscera were examined under stereoscopic microscopy, and the helminths were removed and stored in 70% ethanol. The digeneans were stained with a 1:6 dilution in 96% ethanol of hydrochloric carmine, dehydrated and mounted in Canada balsam. Photomicrographs were taken using a Zeiss Axioplan 2 Microscope. Measurements are given in micrometers (µm). The taxonomy of digeneans is given in accordance to Gibson *et al*. (2002), Jones *et al*. (2005) and Bray *et al*. (2008), and the parasitic indexes used were based on Bush *et al*. (1997). The helminths were deposited in the Helminthological Collection of the Museo de La Plata (MLP), La Plata, Argentina. The abbreviations of the metrical features are as follows: Ho-Ae: distance Holdfast organ-anterior end; Vf-Ae: Distance vitelline follicles-anterior end. Ratios: Pt/At: Posterior testis width/ Anterior testis width; B/Ho: Body length/Holdfast organ length; B/E: Body length/Egg length.

Ten digenean species (four diplostomids, three echinostomatid, one strigeid, one psilostomid, and one prosthogonimid) were found (Table 1).

SUBCLASS DIGENEA CARUS, 1863

Family Diplostomidae Poirier, 1886

Austrodiplostomum Szidat and Nani, 1951

Austrodiplostomum mordax Szidat and Nani, 1951

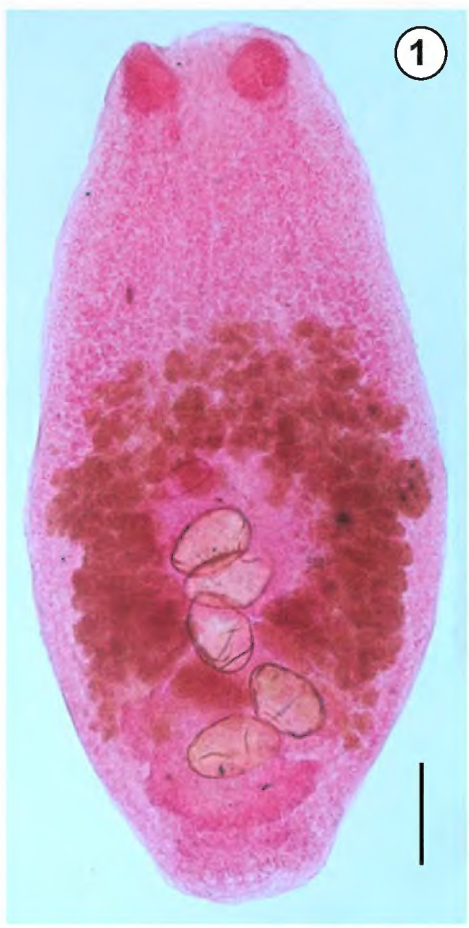
(Figure 1, Table 2).

Adults of this species parasitizing *P. brasilianus* from Buenos Aires Province were described by Szidat and Nani (1951). Dubois (1970) synonymized *A. mordax* with *A. compactum* (Lutz, 1928). Later, Ostrowski de Núñez (1982) recognized both species as valid mainly based

Table 1. Digenean species from *P. brasilianus*: deposit numbers of voucher specimens in MLP, infection sites (BF = bursa Fabricii, I = intestine, LI = large intestine, S = stomach, SI = small intestine), number of examined birds (N), prevalence (P), mean intensity (IM), NH = number of helminths.

PARASITE SPECIES	MLP	INFECTION SITE	BUENOS AIRES PROVINCE		FORMOSA PROVINCE	
			LACOMBE LAGOON (N=11)		PIRANÉ (N=1)	CLORINDA (N=1)
			P (%)	IM (range)	NH	NH
Austrodiplostomum mordax	6411	I	64	32 (1-139)	---	---
Austrodiplostomum ostrowskiae	6412	LI	---	---	10	---
Tylodelphys adulta	6413	SI	---	---	----	20
Hysteromorpha triloba	6414	I	9.1	2	113	1
Strigea falconis brasiliana	6415	SI	---	---	1	---
Ribeiroia ondatrae	6416, 6417	S	55	8.3 (1-27)	2	1
Prosthogonimus ovatus	6418	BF	11	2	---	---
Paryphostomum segregatum	6419, 6420	I	55	4.7 (1-8)		10
Paryphostomum parvicephalum	6421	I	---	---	222	---
Drepanocephalus spathans	6422, 6423	I	45	4.8 (1-12)	132	6

on morphological differences of the larval stages and on the infection site of metacercariae. Most recently, Dronen (2009) considered *A. compactum* a synonym of *A. mordax*, recognizing as members of this species the specimens found parasitizing *P. brasilianus* from Venezuela by Lutz (1928), Nasir and Diaz (1972), and the specimens represented by figures 8 and 9 of Ostrowski de Núñez (1982). Although our specimens are smaller than those previously described from Venezuela and Argentina, they have similar morphological characteristics (Table 2).



Figures 1-4. Digeneans from *P. brasilianus*. 1. *Austrodiplostomum mordax*. Bar = 100 µm. 2. *Austrodiplostomum ostrowskiae*. Bar = 400 µm. 3. *Tylodelphys adulta*. Bar = 100 µm. 4. *Hysteromorpha triloba*. Bar = 200 µm.

***Austrodiplostomum ostrowskiae* Dronen, 2009** (Figure 2, Table 3).

This species was described recently by Dronen (2009) parasitizing the small intestine of *Phalacrocorax auritus* (Lesson) (Phalacrocoracidae) from Texas, USA. The specimens studied here are larger than previously described for *P. auritus* (Table 3), but the morphological characters are in full agreement with this species. Moreover, Dronen (2009) considered members of *A. ostrowskiae* the specimens described as *A. mordax* by Ostrowski de Núñez (1970; 1977), those reported as *A. compactum* by Dubois and Macko (1972), Fedynich *et al.* (1997), and Rietschel and Werding (1978), and the specimens represented by figures 10 and 11 of Ostrowski de Núñez (1982) from Argentina. We consider our specimens to be *A. ostrowskiae*, given that they present similar morphological and morphometric characters to those reported elsewhere (Table 3). The finding of *A. ostrowskiae* in Formosa Province extends its geographical distribution to the Chaco biogeographic province.

***Tylodelphys* Diesing, 1850**

***Tylodelphys adulta* Lunaschi and Drago 2004** (Figure 3).

This species was originally described parasitizing *Podiceps major* (Boddaert, 1783) (Podicipedidae) from Buenos Aires Province, Argentina (Lunaschi and Drago 2004). The finding of *T. adulta* parasitizing *P. brasilianus* in Clorinda adds one new host record and extends the geographical distribution of *T. adulta* to the Chaco biogeographic province.

***Hysteromorpha* Lutz, 1931**

***Hysteromorpha triloba* (Rudolphi 1819)** (Figure 4).

This species was previously reported by Ostrowski de

Núñez (1970) parasitizing the intestine of *P. brasilianus* from Buenos Aires and Córdoba Provinces. The finding of *H. triloba* parasitizing this host from Pirané extends its geographical distribution to Formosa Province.

Family Strigeidae Railliet, 1919

***Strigea* Abildgaard, 1790**

***Strigea falconis brasiliana* Szidat, 1929** (Figure 5).

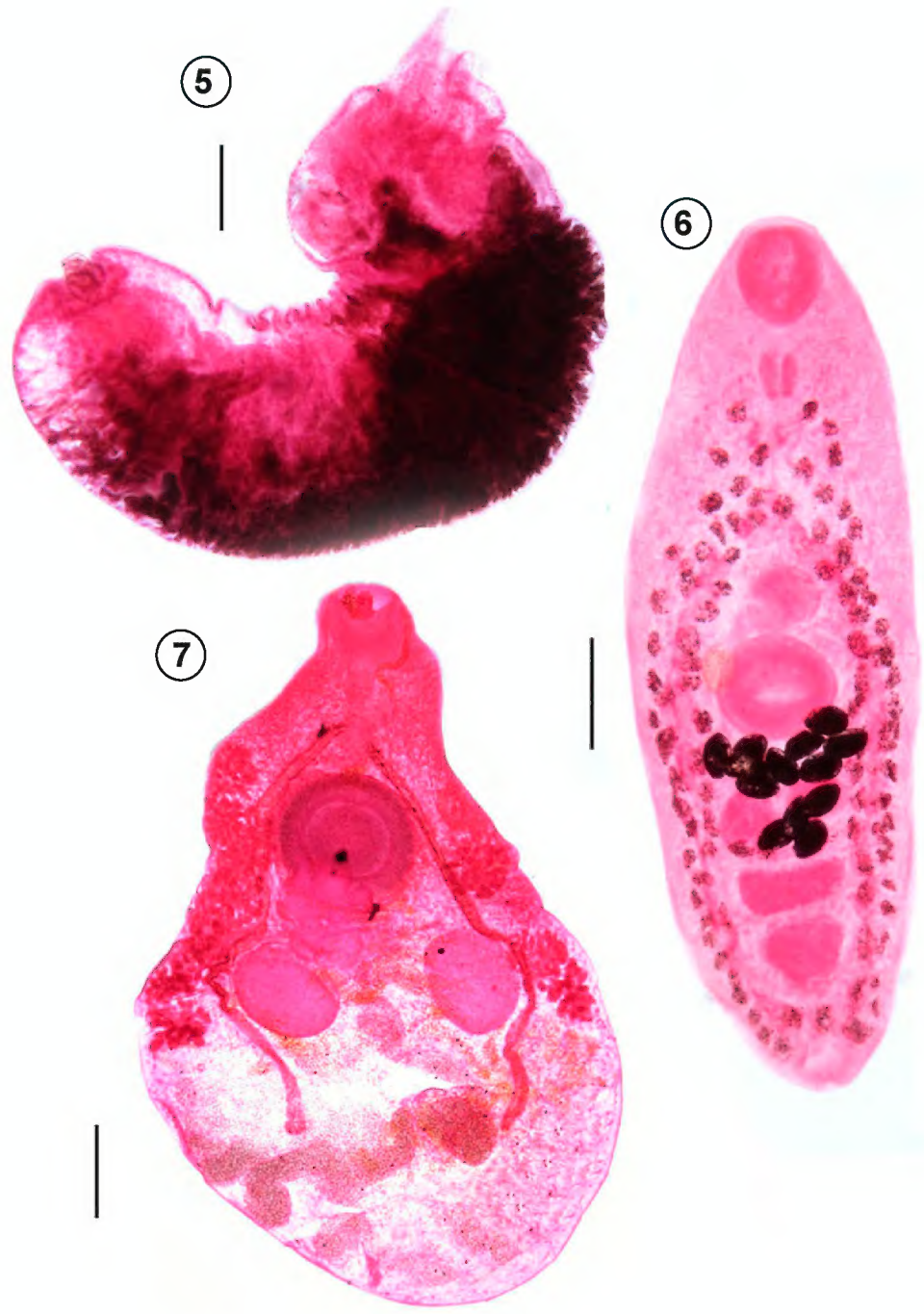
This digenean has been reported parasitizing mainly falconiform birds from Brazil and Cuba, such as *Buteo albicaudatus* Vieillot, 1816, *Buteo magnirostris* (Gmelin, 1788), *Herpetotheres cachinnans* (Linnaeus, 1758), *Caracara plancus* (Miller, 1777), *Spizaetus ornatus* (Daudin, 1800), *Buteo jamaicensis umbrinus* Bangs, 1901 and *Buteo platypterus cubanensis* Burns, 1911 (Pérez Vigueras 1955; Dubois 1970; Dubois and Macko 1972). It was also recovered from *Coragyps atratus* (Bechstein, 1973), *Tigrisoma lineatum* (Boddaert, 1783) (Ciconiiformes), *Sterna* sp., (Charadriiformes) and strigiform birds from Brazil, and *Gallinula chloropus galeata* (Lichtenstein, 1818) (Gruiformes) from Venezuela (Lamothe-Argumedo and Jaimes Cruz 1982; Noronha *et al*. 2009). In Argentina, this species was reported parasitizing *B. magnirostris* from Formosa Province (Lunaschi and Drago 2006). The finding of *S. f. brasiliana* parasitizing *P. brasilianus* represents a new host record and the first record in phalacrocoracid birds.

Family Psilostomidae Looss, 1900

***Ribeiroia* Travassos, 1939**

***Ribeiroia ondatrae* (Price, 1931)** (Figure 6).

In Argentina, this species was previously reported parasitizing the stomach of *P. brasilianus* from Buenos Aires city (Ostrowski de Núñez 1968). It was also reported parasitizing *Spheniscus magellanicus* (Forster, 1781)



Figures 5-7. Digeneans from *P. brasilianus*. 5. *Strigea falconis brasiliana*. Bar = 200 µm. 6. *Ribeiroia ondatrae*. Bar = 200 µm. 7. *Prosthogonimus ovatus*. Bar = 500 µm.

from La Plata Zoological Garden (Boero *et al.* 1972) and *Ardea alba egretta* Gmelin, 1789 from De Monte Lagoon, Buenos Aires Province (Labriola and Suriano 1998). The finding of *R. ondatrae* in Formosa Province extends its geographical distribution to the Chaco biogeographic province.

Table 2. Comparative measurements (in micrometers) of *Austrodiplostomum mordax* Szidat and Nani, 1951 collected in *P. brasilianus*.
*Calculated from original description

REFERENCES	LUTZ (1928)	NASIR AND DIAZ (1972)	SZIDAT AND NANI (1951)	PRESENT STUDY
LOCALITIES	VENEZUELA	VENEZUELA	ARGENTINA	ARGENTINA
Body	1800	1150-1790 x 576-864	1400 x 800	812-1071 x 348-411 (942 x 380)
Oral sucker	---	60-96 in diameter	130 in diameter	64-79 x 59-78 (72 x 69)
Pharynx	---	50-90 in diameter	150 x 40	25-69 x 40-64 (47 x 52)
Holdfast organ	---	235-423 x 206-282	350 x 200	145-188 x 111-159 (167 x 135)
Pseudosucker	---	---	---	71-95 x 59-83 (83 x 71)
Esophagus	---	---	---	36-39 (37)
Ovary	---	---	---	48-55 x 76-79 (52 x 78)
Anterior testis	---	154-238 x 196-420	---	83-93 x 126-147 (88 x 137)
Posterior testis	---	140-154 x 364-560	---	62-83 x 157-193 (73 x 175)
No. eggs	---	4	25-30	2-6 (4)
Eggs	100	112-152 x 56-112	100 x 50	71-107 x 47-69 (89 x 58)
Ho-Ae	---	---	---	382-503 (443)
Vf-Ae	---	---	---	217-406 (312)
Ratios				
Pt/At	---	1.3-1.9*	---	1.2-1.5 (1.3)
B/Ho	---	4,2-4,9*	4*	4.8-6.3 (5.5)
B/E	18*	7,6-16*	14*	9-15 (12)

Family Prosthogonimidae Lühe, 1909

***Prosthogonimus* Lühe, 1899**

***Prosthogonimus ovatus* (Rudolphi, 1803)** (Figure 7).

This species was reported parasitizing the cloaca of *P. brasilianus* from Rio Grande do Sul, Brazil (Monteiro *et al*. 2007). In Argentina, this digenean was reported parasitizing the eggs of *Gallus gallus domesticus* (Linnaeus, 1758) (Galliformes), and the cloaca of *Furnarius rufus* (Gmelin, 1788) (Passeriformes), *Plegadis chihi* (Vieillot, 1817) (Ciconiiformes), *Nothura maculosa* (Temminck, 1815) and *Rhynchotus rufescens* (Temminck, 1815) (Tinamiformes) (Lunaschi *et al*. 2007).

Family Echinostomatidae Looss, 1899

***Paryphostomum* Dietz, 1909**

***Paryphostomum segregatum* Dietz, 1909** (Figure 8).

This species possesses an exclusively Neotropical distribution and was found in Brazil, Argentina, Venezuela, Guyana and Paraguay parasitizing cathartid birds (Drago and Lunaschi 2011). Moreover, in Argentina it was reported by Ostrowski de Núñez (1968) parasitizing *P. brasilianus* from Buenos Aires Province.

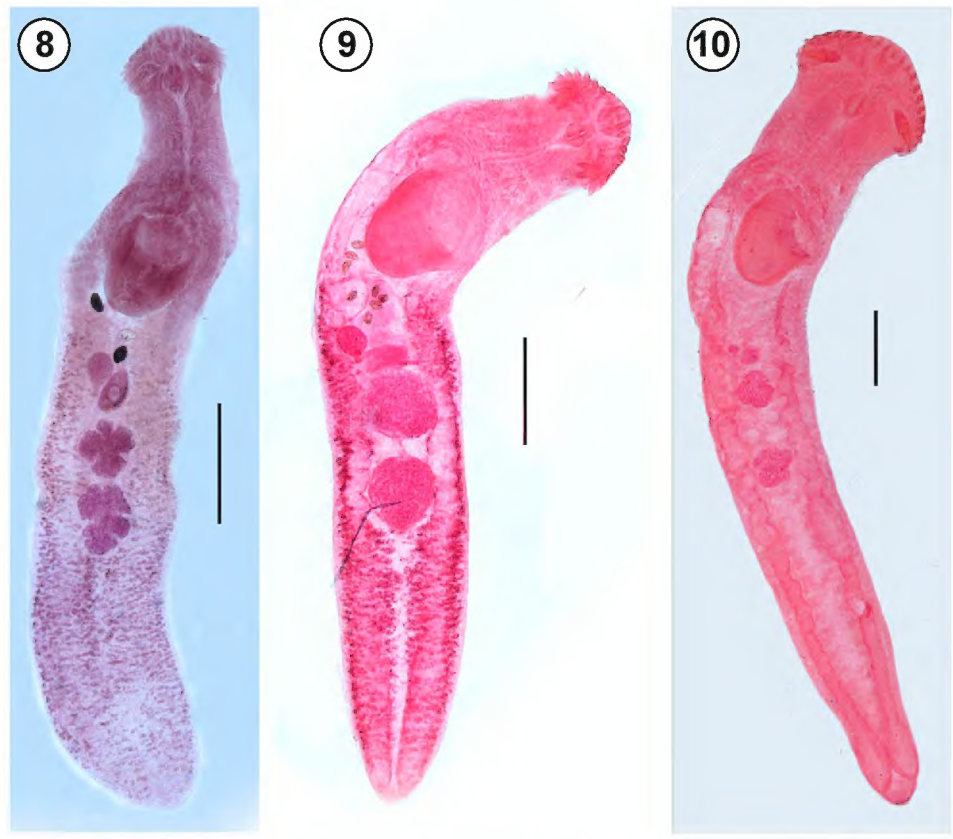
***Paryphostomum parvicephalum* (Rietschel and Werding, 1978)** (Figure 9).

This species was originally described as *Drepanocephalus parvicephalus* Rietschel and Werding, 1978 on the basis of specimens collected from *P. brasilianus* (cited as *P. olivaceus*) and *Sula leucogaster* (Boddaert, 1783) (Pelecaniformes) in Colombia (Rietschel and Werding 1978). Kostadinova *et al.* (2002) transferred this species to *Paryphostomum* Dietz, 1909, mainly based on the morphology and size of the collar spines. Our record is the first from Argentina, extending the geographical distribution of *P. parvicephalum* to the Chaco biogeographic province.

***Drepanocephalus* Dietz, 1909**

***Drepanocephalus spathans* Dietz, 1909** (Figure 10).

This species was reported parasitizing the intestine of *P. brasilianus* from Brazil, Venezuela, Gulf of Mexico, Colombia and Paraguay (Kostadinova *et al.* 2002). It



FIGURES 8-10. Digeneans from *P. brasilianus*. Bar = 500 µm. 8. *Paryphostomum segregatum*. 9. *Paryphostomum parvicephalum*. 10. *Drepanocephalus spathans*.

TABLE 3. Comparative measurements (in micrometers) of *Austrodiplostomum ostrowskiae* Dronen, 2009.
*Calculated from original description.

REFERENCES	DRONEN (2009)	OSTROWSKI DE NÚÑEZ (1970)	DUBOIS AND MACKO (1972)	RIETSCHEL AND WERDING (1978)	PRESENT STUDY
LOCALITY	**USA**	**ARGENTINA**	**CUBA**	**COLOMBIA**	**ARGENTINA.**
Host	*P. auritus*	*P. brasilianus*	*Phalacrocorax auritus floridanus* (Audubon)	*P. brasilianus*	*P. brasilianus*
Body	1110-1425 x 520-700	2240-2500 x 840-1120	2100-2600 x 1000-1300	1180-1600 x 720-936	1685-2486 x 1000-1257
Oral sucker	65-75 x 49-65	58-98 x 69-98	75-105 x 65-85	63-102 x 36-102	76-95 x 93-150)
Pharynx	60-85 x 55-68	87-127 x 75-87	73-94 x 57-80	75-90 x 66-78	98-119 x 69-81
Holdfast organ	250-370 x 125-145	406-638 x 307-464	520-740 x 470-600	423-494 x 447-672	459-725 x 444-774
Pseudosucker	---	----	---	---	126-169 x 76-176
Ovary	57-78 x 88-125	92-127 x 127-179	165-180 x 215-230	66-103 x 141-146	114-152 x 130-193
Anterior testis	112-185 x 198-265	127-232 x 261-377	190-250 x 265-360	155-188 x 237-306	136-314 x 237-416
Posterior testis	100-185 x 215-275	116-232 x 324-452	160-210 x 310-440	118-150 x 291-329	145-251 x 396-503
No. of eggs	7-25	few	70	15-20	17-126
Egg	81-98 x 48-56	87-98 x 40-52	85-100 x 55-65	87-95 x 51-57	76-96 x 45-69
Ho-ae	---	---	---	---	667-1743
Vf-ae	---	---	---	---	338-716
Ratios					
Pt/At	1,03	1,2-1,24*	1.2*	1,1-1,2*	1,2-1,4
B/Ho	3,9-4,4*	3,9-5,5*	3.5-4*	2,8-3,2*	3,2-4,2
B/E	11-18*	23-31*	21-31*	12-18*	18-31

was also reported parasitizing *P. auritus* from Gulf of Mexico and *Sula leucogaster* from Colombia (Rietschel and Werding 1978; Fedynich *et al.* 1997). In Argentina *D. spathans* was found parasitizing *P. brasilianus* from Buenos Aires city by Ostrowski de Núñez (1966; 1968). Our finding of *D. spathans* parasitizing *P. brasilianus* from Formosa Province represents a new geographical record and extends its geographical distribution to the Chaco biogeographic province.

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